Classification of Expansive Soils using the WP4C Dew Point Water PotentiaMeter

Costly engineering mistakes are likely if expansive tendencies of clays in roadbeds and under building foundations are misjudged. Geotechnical engineers therefore need a reliable and quick method to determine how expansive a soil is, such as the one proposed by McKeen (1992). The method uses the slope of a soil moisture characteristic (relation between soil suction and water content for the sample) to classify the sample into one of five categories. Low-numbered categories are "problem" soils. High-numbered categories give little or no expansion when wetted and dried.

The WP4C measures soil suction, and is therefore well suited to classifying expansive soils. The measurement range best suited to expansive soil analysis is from -1 to -100 MPa, which is the approximate range covered by the WP4C. To determine whether a soil is expansive, one first produces a moisture characteristic. This is done as outlined in the Decagon Application Note "Generating a Soil Moisture Characteristic using the WP4C."

Briefly, samples are prepared at a range of water contents and equilibrated overnight or longer in sealed containers. The suctions are then measured with the WP4C, and the water contents are obtained by oven drying. Water content is the mass of water lost on drying divided by the mass of oven dry soil. The WP4C reads out in both MPa and pF (see notes for definition of pF). To perform the McKeen analysis, gravimetric water content is plotted as a function of suction in terms of pF, as shown in the figure. The slope is then easily obtained by fitting a trend line to the data (also shown).

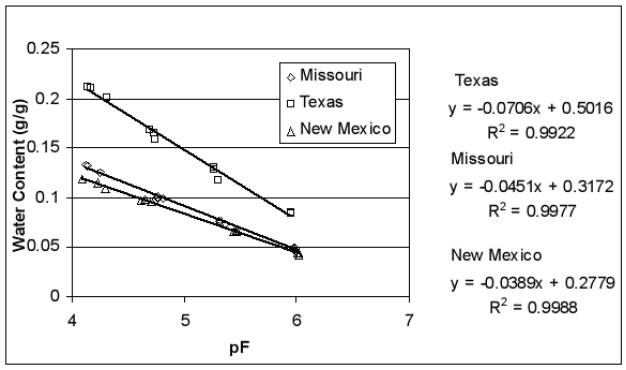

Table 1 on the next page gives the McKeen classification scheme. The second column shows the slope range for each group. For the three soils in the figure, the Missouri and New Mexico samples fall in class V, which are non-expansive. The Texas sample is class IV, which is a low expansion.

Notes

1. pF is defined as the base 10 logarithm of the suction expressed in cm of water. To convert between MPa and pF, first

convert MPa to cm of water. The conversion factor is 10200 cm/MPa. Ignore the negative sign since we can't take the logarithm of a negative number. Now take the base 10 logarithm to get pF. A water potential of -1.0 MPa corresponds to pF 4.01.

2. Air-dry soil is soil that has come to moisture equilibrium with the atmosphere. The water content and water potential of air-dry soil depends on the soil and the humidity of the atmosphere. When starting with a sample of moist or wet soil, soil sufficiently close to air-dry for the purposes of the quick test can be obtained by placing a 1 – 2 mm thick sample of soil in a WP4C sample cup, exposing the soil to the atmosphere for a few hours, and then performing the experiment. Air-dry soil looks dry.

Table 1

Category	Slope	C_h [b]	H [c] (%)	Expansion
I	>0.17	-0.027	10	Special case
II	0.10 to 0.17	-0.227 to -0.12	5.3	High
III	0.08 to 0.10	-0.12 to -0.04	1.8	Moderate
IV	0.05 to 0.08	-0.04 to 0	-	Low
V	<0.05	0	-	Non-expansive

[a] +w /+h is the absolute value of the slope of the moisture characteristic, or change in water content per unit change in pF.
[b] C_h is the suction-compression index, from McKeen (1992).
[c] +h is the vertical movement computed by McKeen (1992).

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